ing antimalaria measures is the establishment in the area concerned of an effective official health unit.

(7) Programs of malaria control should definitely aim at the eventual and even early taking over of activities by the local agencies and their support by local funds.

(8) Antimalaria programs should neither be allowed to take precedence over nor to be subordinated to other health activities in the area. After a careful study of local health needs they should be allotted their proportionate share in health activities.

(9) Malaria is as much due to social and economic causes as to the plasmodium or the mosquito. The problem as to just where to interrupt the vicious circle varies with locality and must be decided after local survey.

(10) Malaria in the United States could be not only controlled but virtually exterminated by methods already known and at not unreasonable cost.

(11) Impediments to malaria control and eradication arise from the well recognized psychological and social phenomena which always delay the adoption of useful innovations, unless the latter happen to come in peculiarly attractive form or are laden with considerable emotional appeal.

(12) It is essential that researches in malaria be continued. Not only are economic refinements of methods desirable, but from the standpoint of science a very productive field awaits further cultivation.

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PARASITOLOGY IN RELATION TO MEDICAL PROBLEMS OF THE SOUTH[1]

THE medical problems of the south include several diseases that are endemic in the region in addition to those that occur over the country as a whole. Some of the more important ones of these diseases are caused by large parasites like, for instance, the helminths, and intelligent dealing with them requires that advantage be taken of information to be derived from that division of parasitology which deals with this class of parasites—helminthology.

Other diseases endemic chiefly in the south are caused by microscopic parasites, the protozoa, and intelligent dealing with them requires practical application of information to be derived from the division of parasitology which deals with this class of parasites—protozoology.

[1] Presented as part of a symposium on "The Medical Problems of the South" at a joint meeting of the American Association for the Advancement of Science and the American Public Health Association, Nashville, December 28, 1927.

The specific organism of some of the diseases of the south that are due to protozoa and some of those that are due to bacteria are transmitted from man to man, or in some instances from animal to man by insects, and these can be dealt with intelligently only by taking advantage of information to be gained from entomology, which we may include as another division of the general subject of parasitology. It often occurs that such a disease may be most successfully combatted by measures directed against the insect host of the specific organism or against the animal host of the insect host of the organism, as in bubonic plague.

The medical problems presented by a disease, parasitic or otherwise, are chiefly those of diagnosis, cure and prevention. Any and all of these are dependent more or less upon a knowledge of the life history of the specific organism or parasite, as in the case, for instance, of hookworm disease, or of both the specific organism and of the insect host as in malaria. Diagnosis is necessary for intelligent treatment of a parasitic disease, but both diagnosis and treatment may be applied only to the individual or either or both of them may be utilized in combatting or preventing the disease in the community. In other instances the cure of patients, as in the case of yellow fever or of plague, has little or no significance in dealing with the disease as a community problem.

Parasitology discovers the life history of the parasite and its environmental requirements for propagation and mischief. Unless we remind ourselves, we are likely not to fully realize how much the success we have had in dealing with several of the diseases that have been dealt with successfully during recent years was made possible by studies of the parasite or its insect host. During comparatively recent years yellow fever has been banished, never to return, thanks to the practical application of knowledge of the life history of the insect carrier; bubonic plague is under control and will never be a serious disease again, thanks to the practical application of knowledge of the life history of the rat-flea and its host; hookworm disease is no longer a serious disease in the south except in limited areas and in small numbers of people compared with twenty years ago, thanks to the practical application of knowledge of the life history of the parasite; malaria has been placed under control and practically eliminated from numerous demonstration communities, thanks to the practical application of knowledge of the life history of both the parasite and the insect host. Numerous other instances could be given in which the problem of endemic diseases has been solved to considerable extent at least through knowledge of the life history

of the parasite or its host, provided largely through parasitology. Let us look more closely into the facts relating to some of these problems.

In 1901 Allen J. Smith (1) discovered hookworm ova in the feces of a number of students at Galveston, Texas, but it was the experienced zoologist, Charles Wardell Stiles (2), who fully recognized the significance of the observation. To him hookworm eggs in these students from different parts of the state could mean nothing less than wide distribution of this parasite. Examination of material from other parts of the south confirmed the opinion and showed that the parasite was widely distributed throughout the southern states.

It took months and, in fact, years for Stiles and others to thoroughly arouse the people of the south to a realization of the existence and importance of this great burden of hookworm disease and its effects upon the health and vitality of a large part of the inhabitants. For his pioneer work, which led to the creation of the Rockefeller Hookworm Commission and later the International Health Board, the country owes him an everlasting debt of gratitude that can never be repaid. Campaigns for the control of hookworm disease were conducted and extended from time to time until they have reached not only most of this country where the disease prevailed, but the four corners of the earth, resulting in untold benefit to many hundreds of thousands of people. These efforts to control the disease have been based largely on a knowledge of the life history of the parasite both outside of and within man that has been worked out by a great deal of scientific research by a host of workers.

Much valuable and indispensable information was supplied by the work of Loos (3) showing the mode of infection and the almost incredible route taken by the larvae in their passage through the skin, the blood vessels, heart and lungs to the intestine. These findings were soon confirmed and extended by Claude A. Smith (4) in this country. More recently most exhaustive studies have been made by a host of workers on the influence of different environmental factors on the hatching and survival of larvae, egg production and many other questions of the greatest practical interest. Great reduction has already been brought about in the prevalence of hookworm disease in the south, but it still remains one of the important medical problems to which parasitology is closely related.

A long warm season, abundant rainfall and a population that has not yet fully recovered from the consequences of a long exhausting war, all create favorable conditions for other intestinal parasites. A large part of the poorer people, especially the children who harbor hookworms and some who do not, also harbor other intestinal worms, ascaris, trichuris, oxyuris and strongyloides. While these probably do not constitute so great a menace to health they are still of great importance, and satisfactory methods of treatment and control, in some at least, await further knowledge of the life history of the parasites. Some of them may prove to have more significance than formerly believed as suggested by the more recent studies of Ransom, particularly on the course of ascaris larvae through the body. Cort and his coworkers are making an exhaustive study of ascariasis at the present time and their results are awaited with interest.

Intestinal protozoa, amoeba and flagellates are widely distributed throughout the south and amoebic dysentery is of frequent occurrence in most parts of the country. There is great need for improved methods of differentiating the pathogenic from the nonpathogenic species, and for improved methods of diagnosing the infection. The mode of transmission and the resistance or survival of the parasites outside of the body offer fields for research of the protozoologist.

The protozoa of the mouth, the tonsils, the vagina, require the most thorough study to determine whether they are pathogenic and the source of infection. Practically all people sooner or later lose their teeth from alveolodental pyorrhea if they are not lost from decay. Protozoa, especially amoeba, are found associated with the pyorrhea lesions. Are they pathogenic or not? Proven fact is what is wanted, not opinion.

Malaria constitutes one of the most important medical problems of the south. For many years it was far the largest cause of morbidity. At the time of the civil war malaria was the largest single cause of death. The prevalence and severity of the disease have gradually but surely declined during the past fifty to seventy-five years. Many years ago it was very prevalent not only in the south but also in large sections in New York, Pennsylvania, even Connecticut, and in Maryland, Ohio, Michigan, Illinois and Indiana. To-day there are only small endemic foci in some of these states and none in others. The area of endemic malaria in the United States has shrunk to not more than one third of its former extent. The rate of decline of the disease has been accelerated considerably during the past ten years, due to the greater activities of health agencies in combatting it in the light of the comparatively recent knowledge of its specific cause and mode of transmission and effective methods of dealing with them.

Prior to the discovery of the malaria parasite the only weapons against this disease, one of the greatest foes to civilization and colonization in warm countries, was quinine which was used extensively and deliberately and, in addition, clearing and drainage

which were done chiefly for developmental purposes. The malaria parasite was discovered by Charles Louis Alphonse Laveran in 1880, and the mosquito was definitely incriminated as the transmitter of the parasite from man to man by Sir Ronald Ross in 1898. Knowing the cause of the disease and the transmitting insect it was desirable to learn all that could be known of the life history in nature of the parasite and of the insect mosquito host. Scientific workers throughout the world, entirely too numerous to name here, have added more and more to our knowledge, and further important studies are being made all the time. Present knowledge has shown where the most vulnerable points are in the life history of both the parasite and the mosquito. Attacks on them at these points have been successful in control of the disease in proportion to the thoroughness with which the measures could be applied.

In numerous instances practically 100 per cent. of control has been obtained in small areas. But the cost in effort and money has limited the control by intensive methods to these small areas as compared with the total area involved. Intensive work plus the more general application of measures directed against the parasite and against the mosquito have led to so great reduction until many are beginning to feel that malaria is no longer a serious problem in the south. Let us hope that there will be no disappointment in this regard. But let me point out the fact that while the decline in malaria prevalence and severity has been much greater during the past ten or twelve years than during any previous period of equal length, the year 1927 has brought a little discouraging news. Reports have been received that malaria incidence has increased noticeably in many localities (and, by the way, a good many of these are in the state of Tennessee). Whether this is only a temporary tendency or not remains for the future to determine.

There is great need for further knowledge about the influences that determine the life and survival of parasites in both the human and the insect host. Why does one man recover from the infection easily and another only with great difficulty? What causes the development of gametes? Why do they survive and infect mosquitoes sometimes and not others? What are the natural conditions, environmental, nutritional and otherwise, besides those already known, that influence mosquito breeding and transmission of malaria? These and many other questions of vital importance await further researches along parasitological lines.

Pellagra is one of the largest and most important medical problems of the south. The generally accepted theory that it is caused by faults in diet has only served to detract from interest in other lines of research as to the true cause of the disease. Until this is discovered we can only surmise as to the possible assistance parasitology may give in the solution of the problem of its control. Experimental transmission of the disease to monkeys by W. H. Harris (5), of New Orleans, in 1913, with material that had been passed through a Berkefeld filter, indicates that the infectious agent belongs to "the filterable viruses," but this does not lessen the probability of transmission of the specific virus by insects as in the case of other virus diseases carried by insects, like yellow fever, dengue, etc. In fact the long definite incubation period of experimental pellagra tends to encourage the thought of an insect host. The field is an inviting one, and as long as so little is known, it is reasonable to suppose that parasitology may help to solve problems of this disease that is killing hundreds in the south every year and from which thousands suffer.

These are only a few of the many medical problems of the south to which parasitology bears close relationship. Not only is research in parasitology to discover facts of practical application in medicine needed, but in my opinion there is great need for more parasitology, medical parasitology if you will, in the curriculum of the medical schools of the south. Medical students should be instructed in parasitology not merely from the standpoint of diagnosis and treatment but they should learn more of the life history of the parasites which cause the parasitic diseases they treat so they will be prepared to take the part they should as practicing physicians in prevention as well as cure.

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WILLEM EINTHOVEN

DR. WILLEM EINTHOVEN, for forty-two years professor of physiology in the University of Leyden, died on September 28, 1927. He was born at Samarang, Java, and studied medicine at the University of Utrecht, receiving assistance from the Dutch government on condition that he would go back to the islands after graduation, to practice. Early in his student career he attracted favorable attention by an able investigation of the mechanism of the motions of pronation and supination of the forearm. While studying physiology under Donders, he developed an active interest in ophthalmology, the influence of which is reflected in several of his earlier researches and is to be perceived in much of his later work.